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(71) Applicant: **LARNASTON LTD.**
80a Southampton Row
London WC1B 4BA(GB)

(72) Inventor: **Smale, Geoffrey Andrew**
19 Redbluff Rise
Campbells Bay Auckland(NZ)

(74) Representative: **Harrison, David Christopher et al**
MEWBURN ELLIS & CO 2/3 Cursitor Street
London EC4A 1BQ(GB)

(54) Fore and aft sails.

(57) A fore and aft sail (10) (e.g. a headsail or mainsail) is constructed with a fore portion (18) and an aft portion (19) in such a way as to have a cross-sectional shape which can vary in response to varying wind conditions, similar to a bird's wing in nature. The sail (10) has lines of directional stability (20) in the luff area (18) extending between the head (12) and the tack (13) to provide a stable fore portion (18). The sail (10) also has lines of directional stability (21,16) which radiate from the clew (14) towards the aft edge (20) of the fore portion (18) of the sail (10). In use the aft edge (20) of this fore portion (18) becomes the collector for the majority of the stresses at the clew (14). Where the aft portion (19) is formed from woven material the aft portion (19) can be made up of a series of substantially triangular panels (19A-19E) with the lines of directional stability formed by the warp or the weft of the fabric being aligned along one long edge (21,16) of each substantially triangular panel (19A-19E). Alternatively, the lines of directional stability may be formed from strips of material (60,61), e.g. tapes or the like, superimposed on the surface of a sail (50).

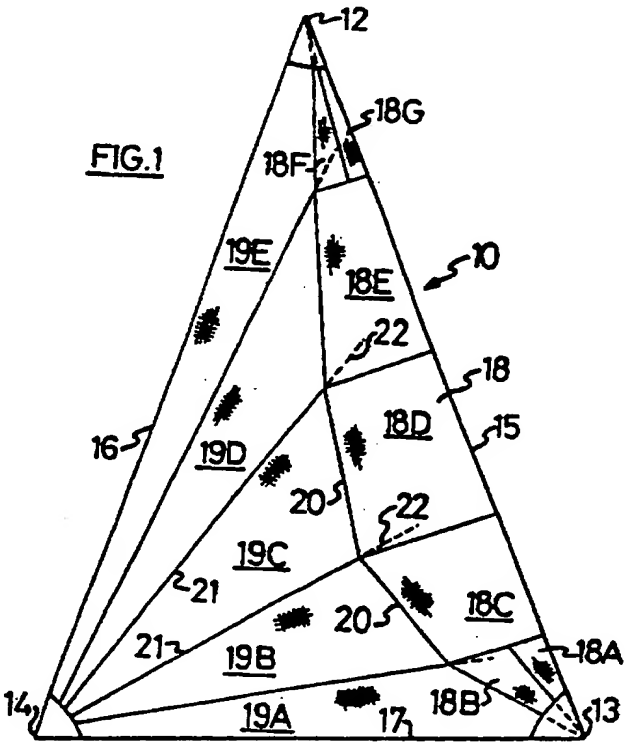


FIG.1

EP 0 271 215 A1

FORE AND AFT SAILS

This is invention is concerned with fore and aft sails e.g. headsails viz. jibs and genoas; and mainsails. Such fore and aft sails are generally triangular and have a luff edge, a leech edge, and a foot edge.

In our European Patent Specification 0126614 A1 we described a new form of sail in which the sail is characterised by the presence of a material or materials in the luff area, which material or materials provide substantially continuous lines of directional stability through the luff area spaced away from the luff edge and extending between the vicinity of the head and the vicinity of the tack of the sail, with the lines of directional stability being in a direction in which the material or materials have a relatively high resistance to elongation under tension.

That concept was equally applicable to the foot area of the sail, and by that means it is possible to produce a sail that is much stronger and more stable under varying wind conditions. That earlier invention minimised any tendency of the sail to change shape due to bias stretch in the luff area of the sail, as was prevalent with earlier sails.

Our earlier invention will for convenience be referred to by referfence to our trade mark POWER LUFF sails, and any reference to POWER LUFF sails, or the POWER LUFF concept, is deemed to be a reference to the contents of our European Patent specification #0126614A1.

Following the introduction of the POWER LUFF concept, the sail making industry has concentrated on aligning panels of the luff, leech, and foot with the stress lines appearing in the sail as a family of curves, each family of stress lines extending from the head to the tack (in the luff area) from the head to the clew (in the leech area) and from the tack to the clew (in the foot area).

By providing lines of directional stability in the luff area, the luff portion has successfully held the shape of the sail forward, and with reinforcement in the leech and foot areas, it has been possible to produce an extremely strong sail with the major emphasis being on the leech strength. Using the POWER LUFF concept, sailmakers have created a very strong and rigid sail.

However, it is desirable for the sail to have a cross-sectional shape which can vary in response to varying wind conditions, similar to a bird's wing in nature.

It is an object of this invention to provide improved fore and aft sails, capable of varying their cross-sectional shape in response to varying wind conditions, or which will at least provide sail makers with a useful choice.

In one aspect, the invention provides a fore and aft sail, with a head, tack and clew, the sail having at least two main portions, a fore portion in which the directional stability of material means transmits stress loads in the luff area to the head and tack of the sail, and an aft portion in which the directional stability of material means radiates out from the vicinity of the clew to the vicinity of at least the aft edge of the fore portion in such a manner to ensure that a proportion of the loads being placed on the clew are able to be transmitted by the directional stability of the material means to at least the aft edge of the fore portion when the sail is under load and properly tensioned. substantially tetragonal panels may be divided into two or more substantially triangular panels as at 24A-24B.

Figure 3 shows a headsail 30 having a fore portion 31 and an aft portion 32. A larger number of panels are shown in the aft portion, and these aft panels 33 are separated by join lines 34 35 36 and 37, so that the lines of directional stability will approximate to curves in the aft portion. The lines of directional stability 39 may also extend beyond the aft edge of the fore panel, as shown by dotted lines 40 extending into the fore panel.

Figure 4 shows a similar headsail with the lines of directional stability 39 also approximating curves in some portions of the aft portion.

Figure 5 shows a mainsail in accordance with this invention having a fore portion 40 and an aft portion 41. The aft portion is similarly formed from a series of panels to provide lines of directional stability radiating outwardly from the clew to at least a central region of the aft edge 42 of the fore portion 40.

Figure 6 shows a similar mainsail with the addition of further panels, in the aft portion.

Figure 7 shows a similar mainsail with the addition of strips of reinforcing material 44 superimposed on the surface of the fore portion 40 of the sail which is itself make up of substantially triangular panels 18A-18E. It is thus a composite of the ideas embodied in Figures 1-6 and those of Figures 8-13. The converse arrangement is also possible as shown in Figure 14, i.e. strips or tapes in the aft portion as in the aft portion of Figure 14 but panels in the front portion of Figure 14 of the type shown in Figure 1 or Figures 5 and 6.

Figure 8 shows a headsail 50 having a fore portion 51 and an aft portion 52. This sail can be formed from a single large panel, or more conveniently a series of panels 53 54 55 56, in which the

Figur s 8 - 11 Show headsails formed with strips of material superimposed on the surface of the sail to create the lines of directional stability in the fore portion and aft portion of the sail in accordance with this invention.

Figures 12 - 13 Show mainsails having strips of material superimposed on the fore portion and aft portion to provide the lines of directional stability in accordance with this invention.

Figure 14 Shows a mainsail having panels in the fore portion similar to Figures 5 and 6 but with tapes in the aft portion similar to Figure 12.

The invention in its simplest form radiates straight lines of directional stability from the clew towards the aft edge of the fore portion of the sail. Thus the aft edge of this fore portion can become the collector for the majority of the stresses at the clew. In this form, the aft portion could be formed from a single panel, preferably with the lines of directional stability being such that at least one of them will extend from the clew and intersect with the aft edge of the fore portion towards the centre of the sail.

If the aft portion is formed from a single panel, e.g. of a woven material, then the lines of directional stability can be chosen such that the warp or weft threads are arranged that the warp or weft threads are parallel to this single line of directional stability. However, it is preferred that a series of lines of directional stability radiate outwardly from the clew towards the aft edge of the fore portion, and this can be achieved with woven material, by forming the aft portion from a series of panels as shown in Figures 1-7. Alternatively, the lines of directional stability may be formed from strips of material, e.g. tapes or the like, superimposed on the surface of the sail as shown in Figures 8-13. In a more complicated form of the invention, a number of the lines of directional stability radiate from the clew in a series of curves, (or approximate curves) to at least the rear edge of the fore portion. These curves may be approximated through a number of straight lines segments, as would be evidenced by a series of panels of woven material with either the warp or weft threads being aligned with the lines of directional stability as described above. Examples of this is shown in Figures 3 and 4. Similarly, curves can be achieved by the use of strips or tapes, as shown in Figures 10 and 11.

Any length of sail material will have a certain elongation at a specific loading. Thus the objective becomes one of transmitting the loads at the clew to the aft edge of the fore portion consistent with maintaining the ability of the leech of the sail to react dynamically to changing wind conditions and thus varying its cross-sectional shape in the chosen manner. It will be appreciated that sail makers will have different ideas on how to vary the cross sectional shape of the sail, and may wish to chose their own version of the aft portion in order to control the "softness" of the leech.

In order to cause panels to carry a higher proportion of the overall loads it is believed that the lines of directional stability should be as straight as possible and generally as short as possible. When the lines of directional stability are curves, then more elongation can occur when the sail is under load. The rigidity or resistance to elongation of the lines of directional stability will play a major part also.

Typically, the high proportion of straight lines of directional stability in the centre of the aft portion of the sail will mean that a substantial proportion of the loads at the clew can be transmitted via these lines or panels to the fore portion and thereby to the head and the tack. This is contrary to current technology which involves transmitting the loads from the clew up the leech and along the foot. It is believed that the sails of the present invention will result in there being significantly less load being carried by the leech than is the case in a conventional tri-radial sail. Currently, it is the leech that breaks down first in conventional sails, and conv ntional sailmaking technology has concentrated on making the leech very strong in an attempt to carry these loadings. It is believed that the sails of the present invention will have a substantially longer life than current sails, as the sails of this invention will not have to carry the heavy loading on the leech. This also means the new sail will not have to be as rigid as in the past. Thus the sails of the present invention will become dynamic in their response to changing wind conditions. The sails of the present invention can also have a "softer" leech than conventional sails.

Turning now to Figure 1 there is illustrated a headsail having a head 12, a tack 13 and a clew 14. The drawings show that the head portion, tack portion and clew portion can be reinforced by a substantially triangular gusset or the like. The other panels of the sail will generally extend into the corners of the sail hidden by these gussets, such that if reference made to a triangular panel extending into the head, it will be appreciated that a portion of this triangular panel will be obscured by the small triangular portion reinforcing the head 12.

The sail 10 shown in Figure 1 has a luff edge 15, a leech edge 16 and a foot edge 17. It is preferably divided into two main portions, a fore-portion 18, and an aft-portion 19.

The fore portion 18 can be formed in the manner of our POWER LUFF concept, e.g. it may be formed from a series of panels 18A-18G, each formed from woven material having the warp or weft thereof aligned in such a way that the aft edge 20 of the fore portion 19 is aligned with the warp or

weft to provide lines of directional stability extending from the head to the tack of the sail. For convenience, the thread lines are shown by cross-hatching along side each major panel edge.

It will be appreciated that the fore portion 18 can be provided in a great variety of shapes of panels, or with superimposed reinforcements, e.g. tapes, or by forming the fore portion from a single panel or plurality of panels in which the lines of reinforcement are precast or moulded therein. At present, it will be generally convenient to form the fore portion 18 from woven sail material, but if an non-woven material is used, the lines of directional stability may be preset in the material so as to approximate the lines of stress in the sail between the head and the tack under normal sailing conditions.

In Figures 2-6, the fore portion 18 is shown as a single panel, in order to concentrate on the construction of the aft portion. Nevertheless, it will be appreciated that the fore portion can be constructed in accordance to the fore portion of Figure 1, or in accordance with the examples shown in our European patent application #0126614A1 (or equivalents thereof) or in any other way that provides directional stability between the head and the tack.

In Figure 1, it is preferred that the aft portion is formed from a series of panels 19A-19E, each of which is formed from woven material with its warp or weft aligned as shown by the cross-hatching. This allows a series of principal lines of directional stability to radiate outwardly from the clew 14 to intersect the aft edge 20 of the fore portion. These principal lines are formed by the seam lines joining the panels together. If desired, the radiating lines of directional stability 21 can extend beyond the aft edge 20 of the fore portion, as shown by dotted lines 22, e.g. this could be achieved by overlapping the aft panels with the fore panels, or by extending a reinforcing seam or tape along the seam line 21 into the fore portion.

Figure 2 shows a similar headsail 25 divided into a fore portion 26 and an aft portion 27. The aft portion 27 being provided with a plurality of panels, some of which are substantially triangular (19A-19E) and some of which are substantially tetragonal panels (23A-23C) which terms are deemed to include references to polygonal panels which approximate these shapes. Some of the substantially tetragonal panels may be divided into two or more substantially triangular panels as at 24A-24B.

Figure 3 shows a headsail 30 having a fore portion 31 and an aft portion 32. A larger number of panels are shown in the aft portion, and these aft panels 33 are separated by join lines 34 35 36 and 37, so that the lines of directional stability will approximate to curves in the aft portion. The lines of directional stability 39 may also extend beyond the aft edge of the fore panel, as shown by dotted lines 40 extending into the fore pan l.

Figure 4 shows a similar headsail with the lines of directional stability 39 also approximating curves in some portions of the aft portion.

Figure 5 shows a mainsail in accordance with this invention having a fore portion 40 and an aft portion 41. The aft portion is similarly formed from a series of panels to provide lines of directional stability radiating outwardly from the clew to at least a central region of the aft edge 42 of the fore portion 40.

Figure 6 shows a similar mainsail with the addition of further panels, in the aft portion.

Figure 7 shows a similar mainsail with the addition of strips of reinforcing material 44 superimposed on the surface of the fore portion 40 of the sail which is itself made up of substantially triangular panels 18A-18E. It is thus a composite of the ideas embodied in Figures 1-6 and those of Figures 8-13. The converse arrangement is also possible as shown in Figure 14, i.e. strips or tapes in the aft portion as in the aft portion of Figure 14 but panels in the front portion of Figure 14 of the type shown in Figure 1 or Figures 5 and 6.

Figure 8 shows a headsail 50 having a fore portion 51 and an aft portion 52. This sail can be formed from a single large panel, or more conveniently a series of panels 53 54 55 56, in which the orientation of the thread lines of the panels is not as important as the orientation of the lines of directional stability of a series of strips of material, e.g. tapes 60, 61, superimposed on the surface of the material.

The fore portion of the sail is formed from a series of tapes 60 superimposed on the sail and forming curves extending from the vicinity of the head to the vicinity of the tack of the sail. The aft most tape 60D defines the outermost edge of the fore portion 51. A series of tapes 61 radiate outwardly from the clew, the majority of these extending towards the tape 60D, although some of them may extend beyond this aft edge of the fore portion, as shown by dotted lines 62, e.g. some of them may extend into contact with one or more of the other tapes 60A-60C.

Not all of the lines of directional stability extending outwardly from the clew need intersect the aft edge of the fore portion, e.g. lines 65 can extend from the clew to the tack of the sail in order to reinforce the foot area thereof.

Figures 7 - 11 show similar fore sails, with that of Figure 11 showing the lines 61 extending across each of the lines 60, so as to terminate at line 60A in the fore portion of the sail.

Figures 12 to 14 show mainsails having the lines of directional stability in the aft portion of the

sails defined by strips of material superimposed on the sail, in a similar manner to that described in Figures 8 - 11. It will be noted that Figures 12 and 13 show strips in the fore portion also but that Figure 14 shows panels in the fore portion.

It will be noted that where curved lines are generated by the lines of directional stability the curved lines of directional stability have a progressively greater curve (having a smaller radius) the nearer the line (or group of lines) of directional stability is to the vicinity of the head and the vicinity of tack of the sail from the vicinity of the centroid of the sail. This can be seen in figure 8 where the centroid is indicated by a circle.

These curved lines can be formed by strips or by two or more panels with straight lines of directional stability joined at an angle so that the path followed by the joined lines will approximate a curve.

For the purpose of this specification "the main body of the sail" is defined as those areas in the central portion of the sail bounded by the vicinity of the head and the vicinity of the tack of the sail.

It will be appreciated from the above description that various methods of constructing the sail can be used, e.g.:

(a) From a panel or series of panels that have been precast or moulded to align a proportion of the lines of directional stability in the manner described above.

(b) From a panel or series of panels adhered or attached to the surface of other material to align a proportion of the lines of directional stability in that panel in the manner described above.

(c) From a panel or series of panels, that panel(s) may be comprised of one or more layers of material, not all of the layers having to have a proportion of their lines of directional stability aligned in the manner described above.

(d) From panels of material means in the fore portion of Figure 1 but with tapes or strips of reinforcing material superimposed on the material means of the aft portion as shown in the aft portions of Figures 8-14.

(e) From panels of material means in the aft portion as in Figures 1-7 but with tapes or strips of reinforcing material superimposed on the material means of the fore portion as in the fore portions of Figures 7-13.

The fore portion of the sail can be formed as a single panel, or a series of panels in the luff area of the sail, possibly extending beyond the bounds of the luff area of the sail, and arranged so as to transmit a substantial proportion of the loads in this fore portion to the vicinity of the head and the vicinity of the tack of the sail.

Finally, it will be appreciated that various alterations or modifications may be be made to the foregoing without departing from the scope of this invention as exemplified by the following claims.

Claims

1. A fore and aft sail (10), with a head (12), tack (13) and clew (14), the sail (10) having at least two main portions comprising a fore portion (18) and an aft portion (19) each portion (18,19) comprising or including material means having directional stability, the fore portion (18) having the directional stability (20) of material means arranged so that the directional stability of the material means (18A-18E) in the fore portion (18) transmits stress loads in the luff area (18) to the head (12) and tack (13) of the sail (10), CHARACTERISED IN THAT the directional stability (21) of the material means (19A-19E) in the aft portion (19) is arranged so that it radiates out from the vicinity of the clew (14) to the vicinity of at least the aft edge of the fore portion (18) in such a manner to ensure that a significant proportion of the loads being placed on the clew (14) are able to be transmitted by the directional stability (21) of the material means (19A-19E) in the aft portion (19) to at least the aft edge of the fore portion (18) when the sail (10) is under load and properly tensioned.

2. A fore and aft sail (10) as claimed in claim 1 CHARACTERISED IN THAT there is more than on line of directional stability (21) radiating out from the vicinity of the clew (14) to the vicinity of at l ast the aft edge of the fore portion (18) of the sail (10).

3. A fore and aft sail (10) as claimed in claim 1 or 2 CHARACTERISED IN THAT the fore portion (18) of the sail (10) is formed from a series of panels (18A-18E).

4. A fore and aft sail (10,50) as claimed in claim 1 or 2 CHARACTERISED IN THAT the fore portion (51) of the sail (50) is formed from strips of material means (60) superimposed on the surface of the sail (10).

5. A fore and aft sail (10) as claimed in any one of claims 1 to 4 CHARACTERISED IN THAT the aft portion (19) of the sail (10) is formed from a series of panels (19A-19E).

6. A fore and aft sail (10,50) as claimed in any one of claims 1 to 4 CHARACTERISED IN THAT the aft portion (52) of the sail (50) is formed from strips of material means (61) superimposed on the surface of the sail (50).

7. A fore and aft sail (10,50) as claimed in claim 4 or claim 6 CHARACTERISED IN THAT the strips of materials means (60,61) are placed on the surface of the sail (50) in such a manner that at least some of them approximate a curve (or curves).

8. A fore and aft sail (10) as claimed in claim 5 CHARACTERISED IN THAT the aft portion (19) of the sail (10) is formed from at least three polygonal (substantially triangular) panels (19A-19E) extending from the vicinity of the clew (14).

9. A fore and aft sail (10,25) as claimed in claim 8 CHARACTERISED IN THAT the aft portion (19,27) of the sail (10,25) includes at least one polygonal (substantially tetragonal) panel (23A-23C) attached to at least one of the at least three polygonal (substantially triangular) panels (19A-19E).

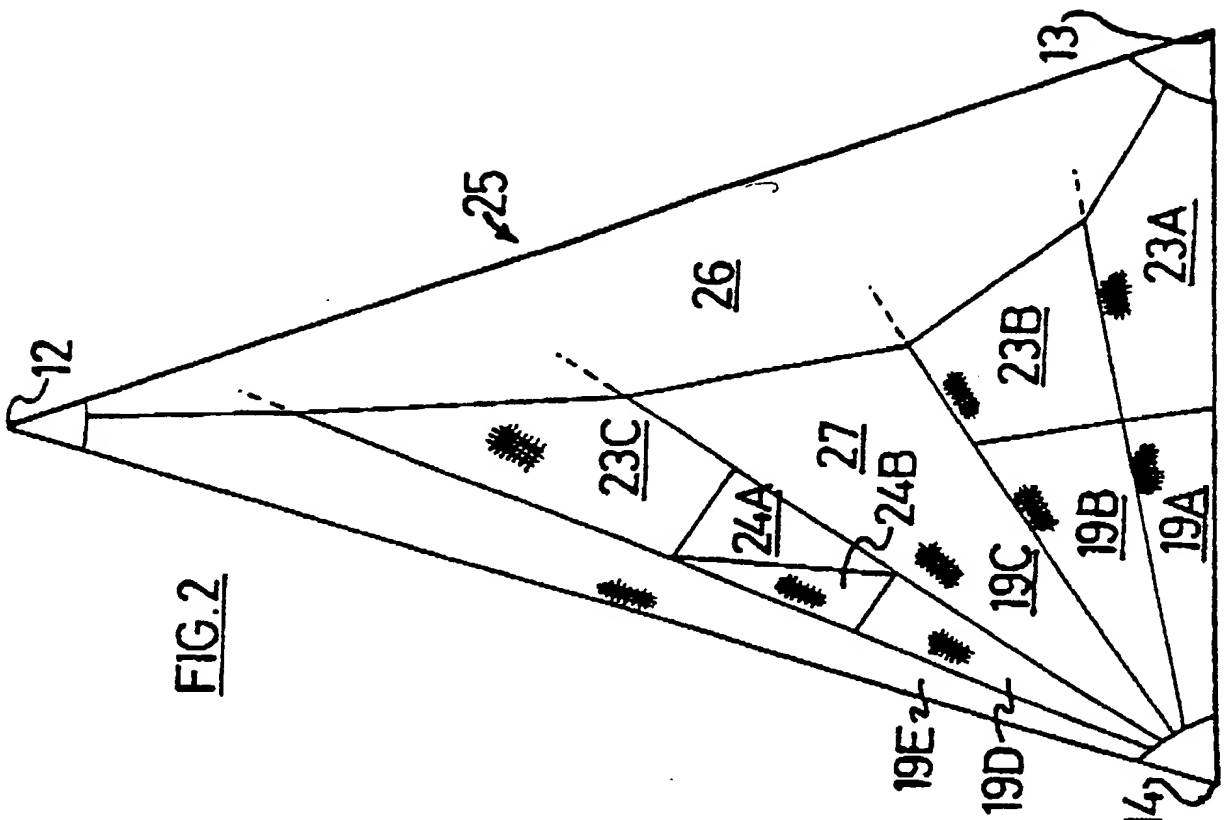


FIG.2

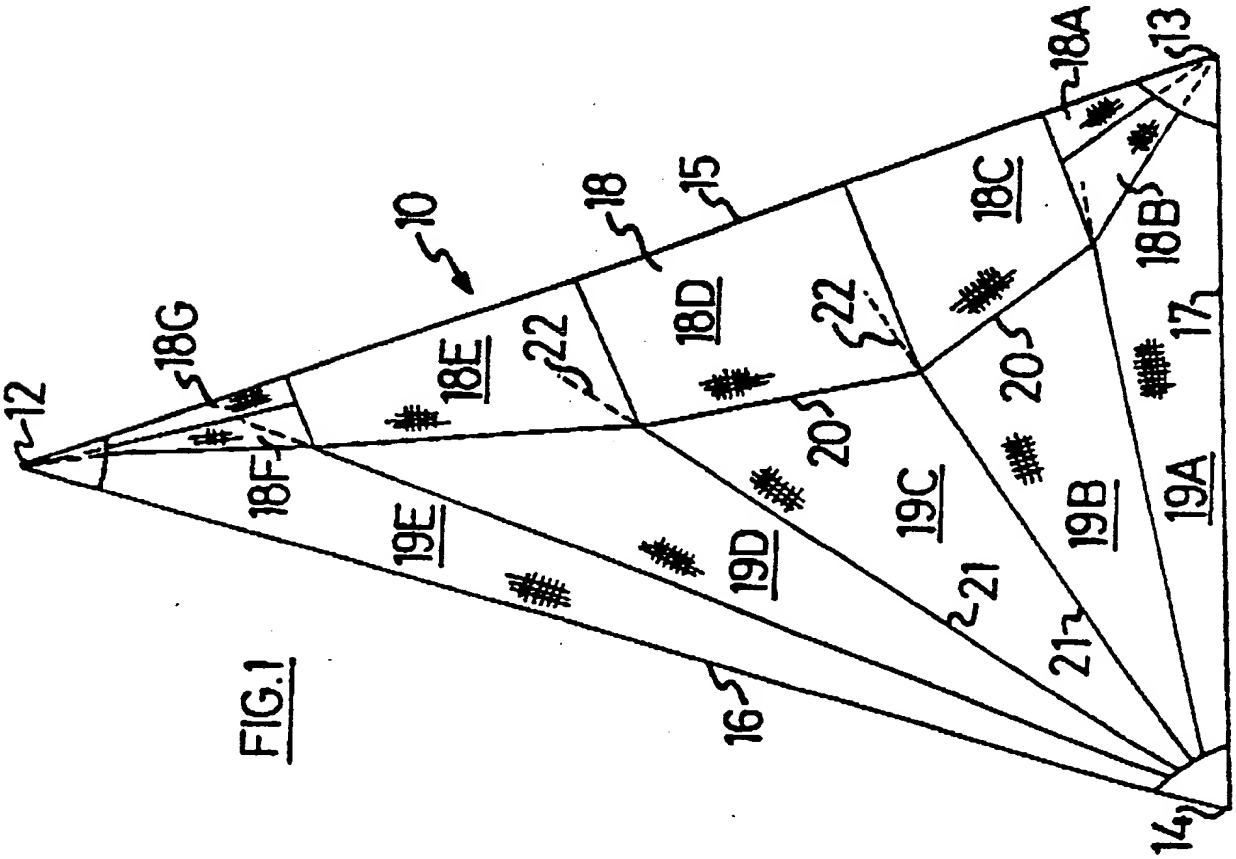


FIG.1

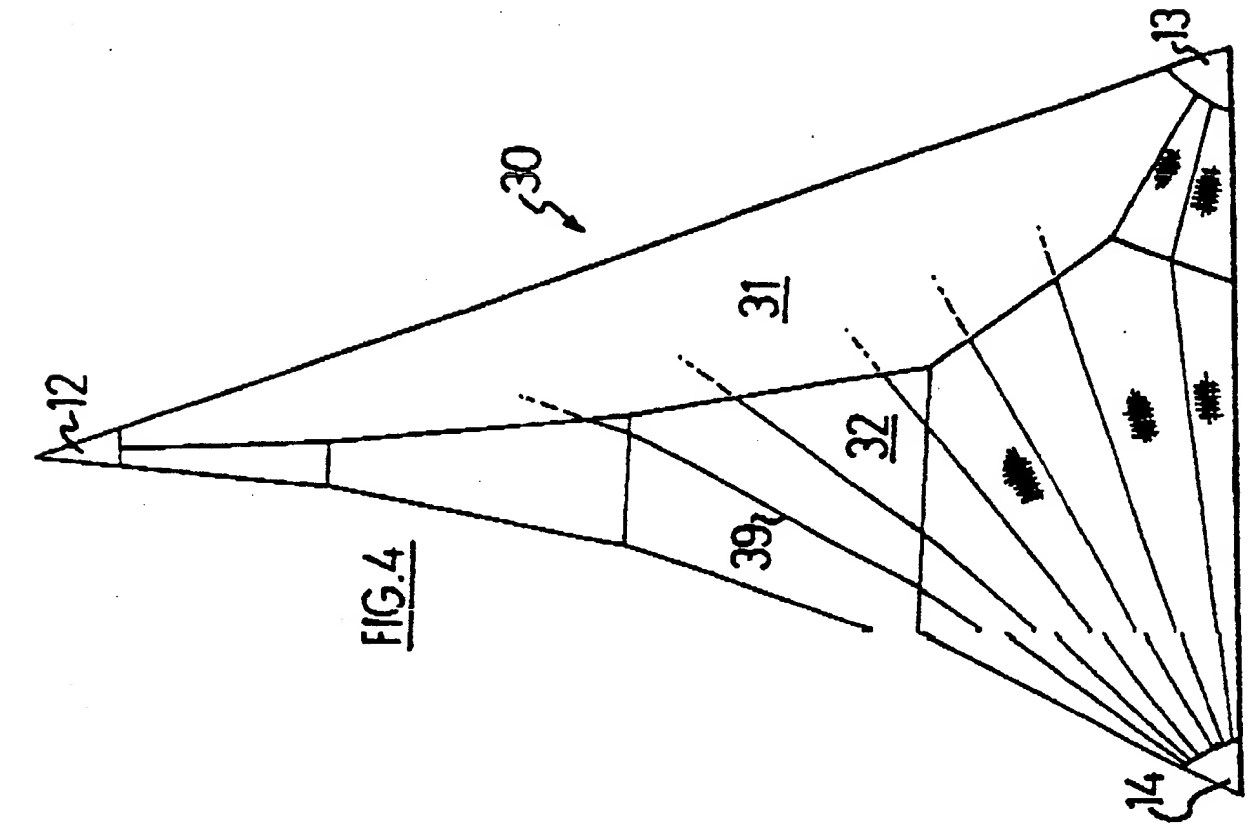


FIG.4

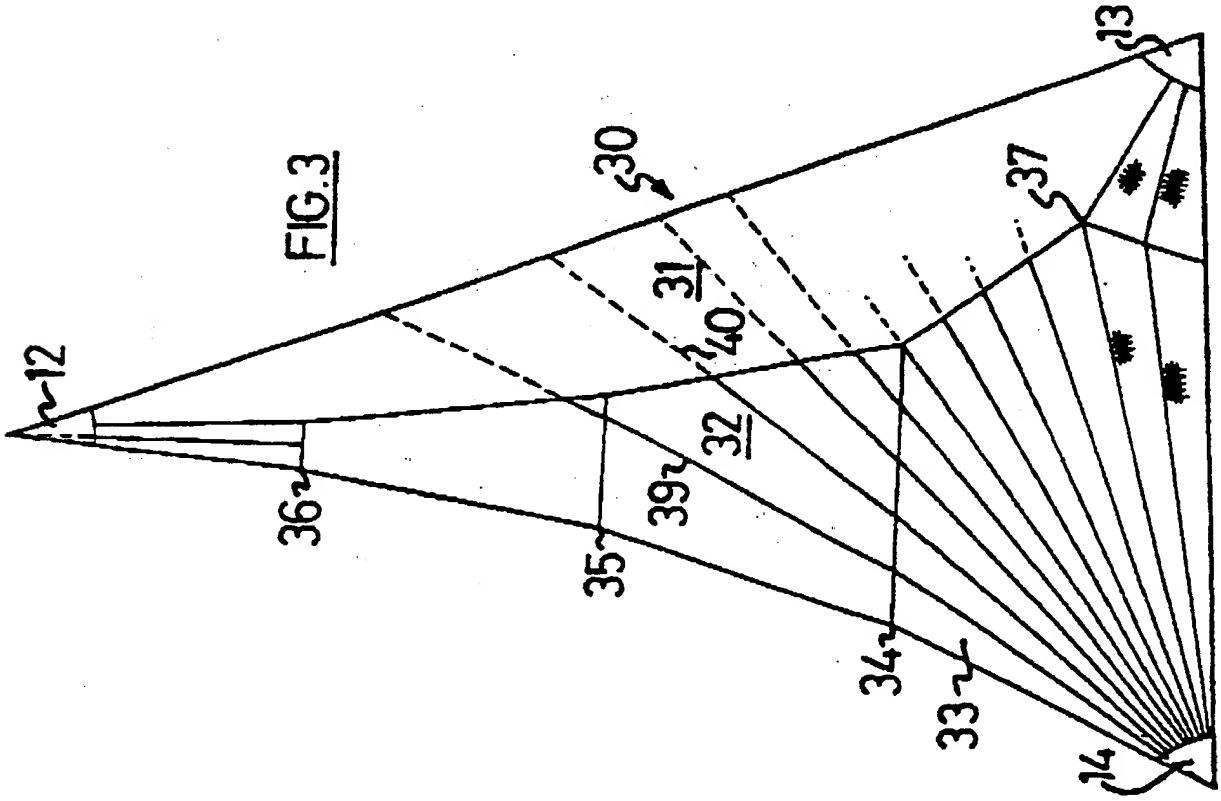


FIG.3

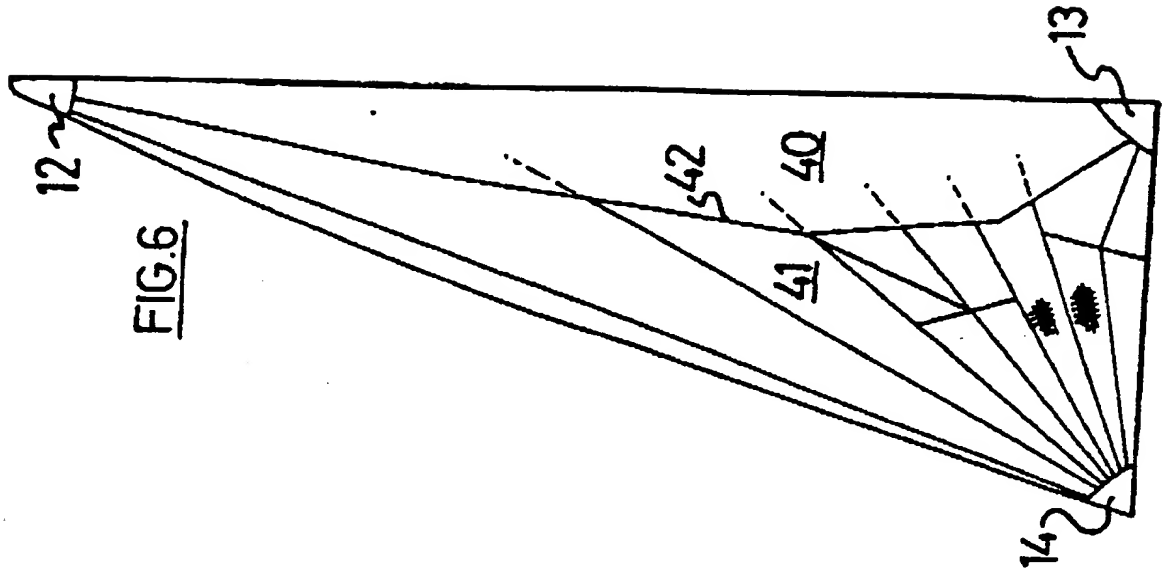


FIG.6

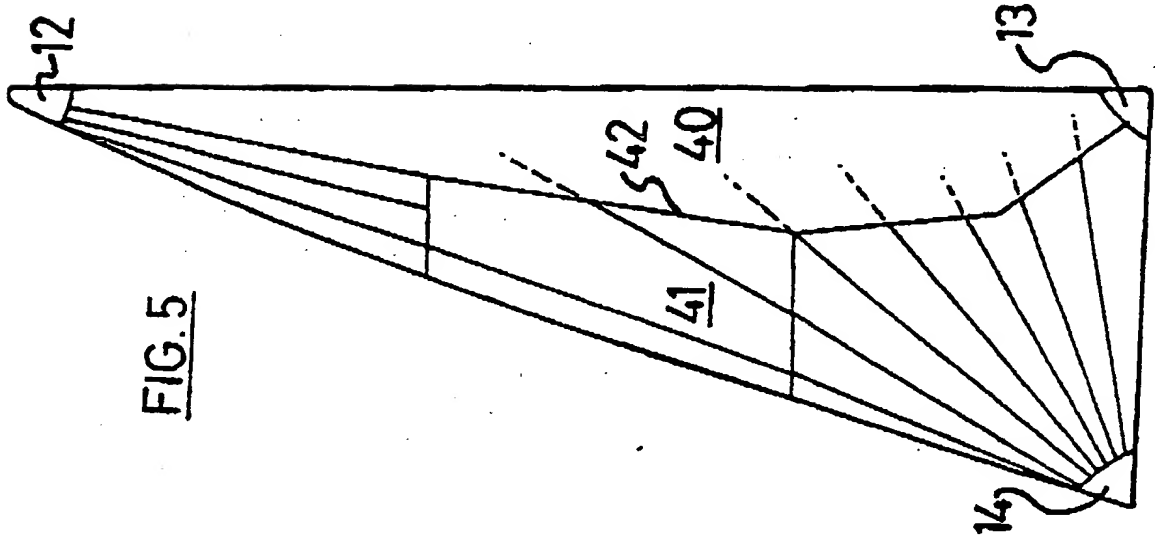


FIG.5

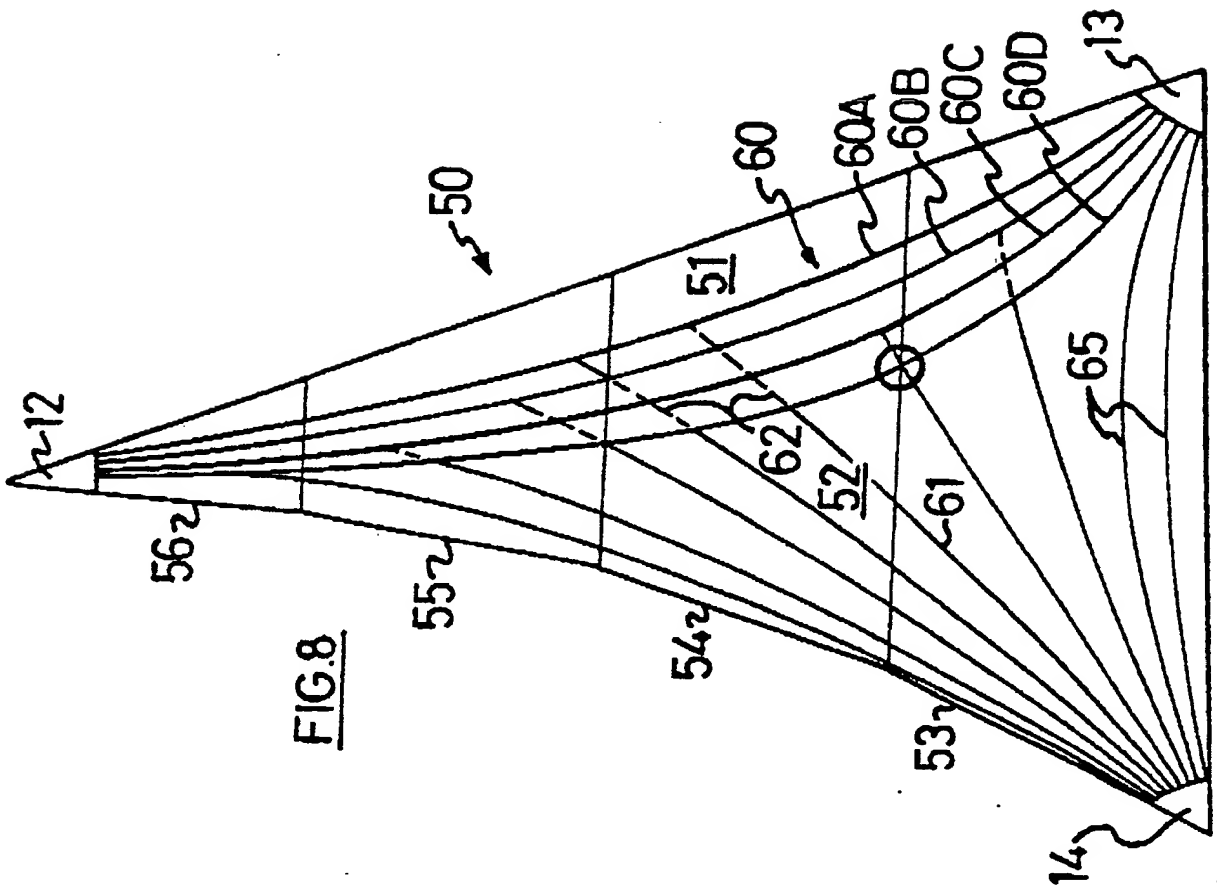


FIG.8

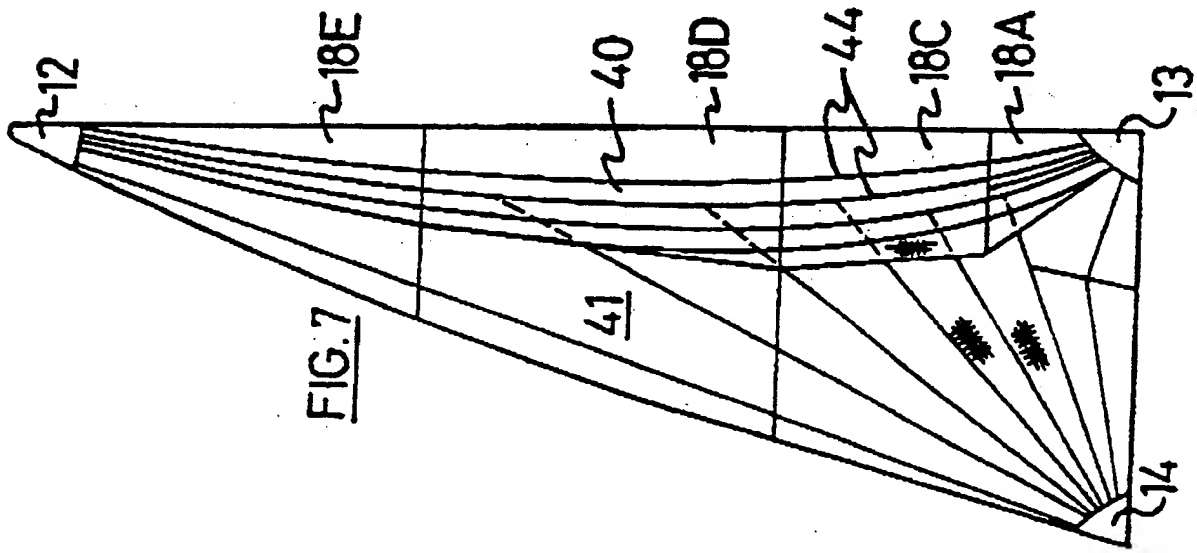


FIG.7

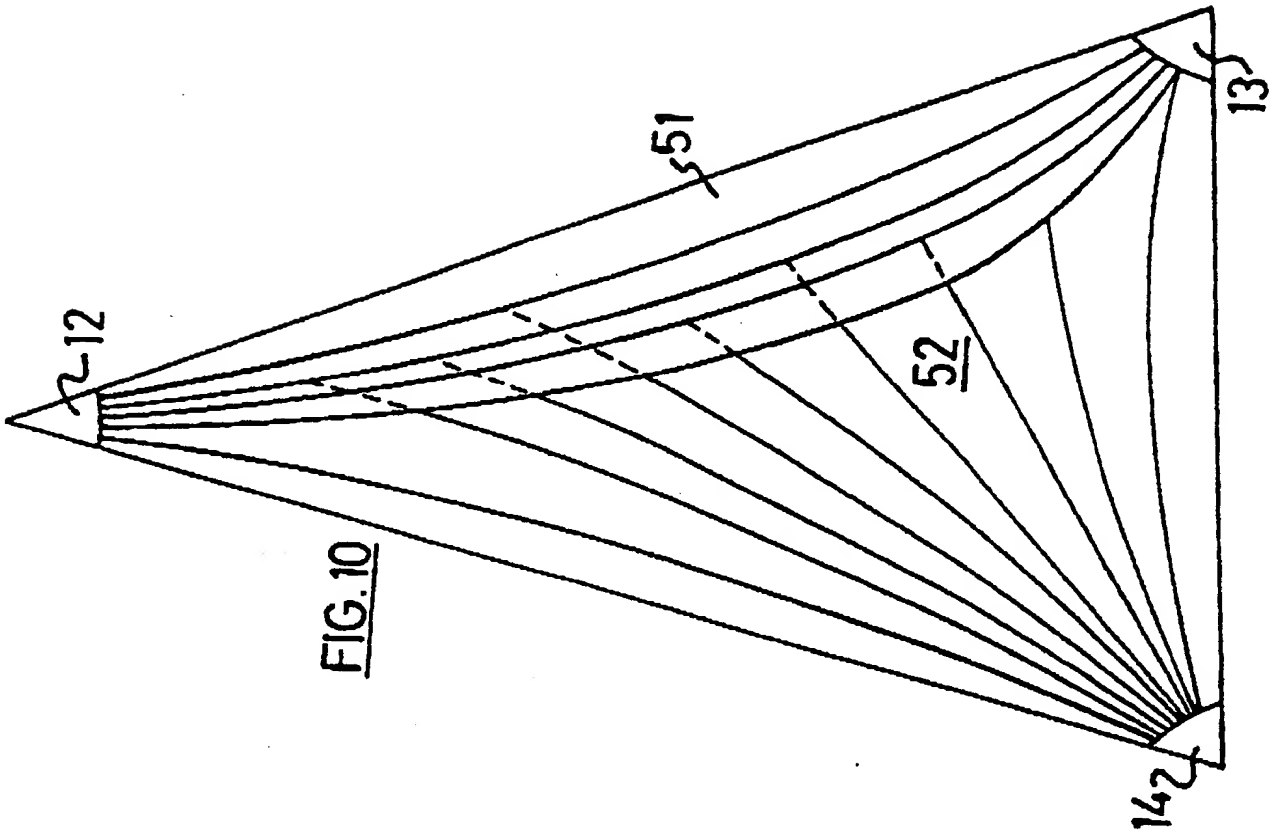


FIG.10

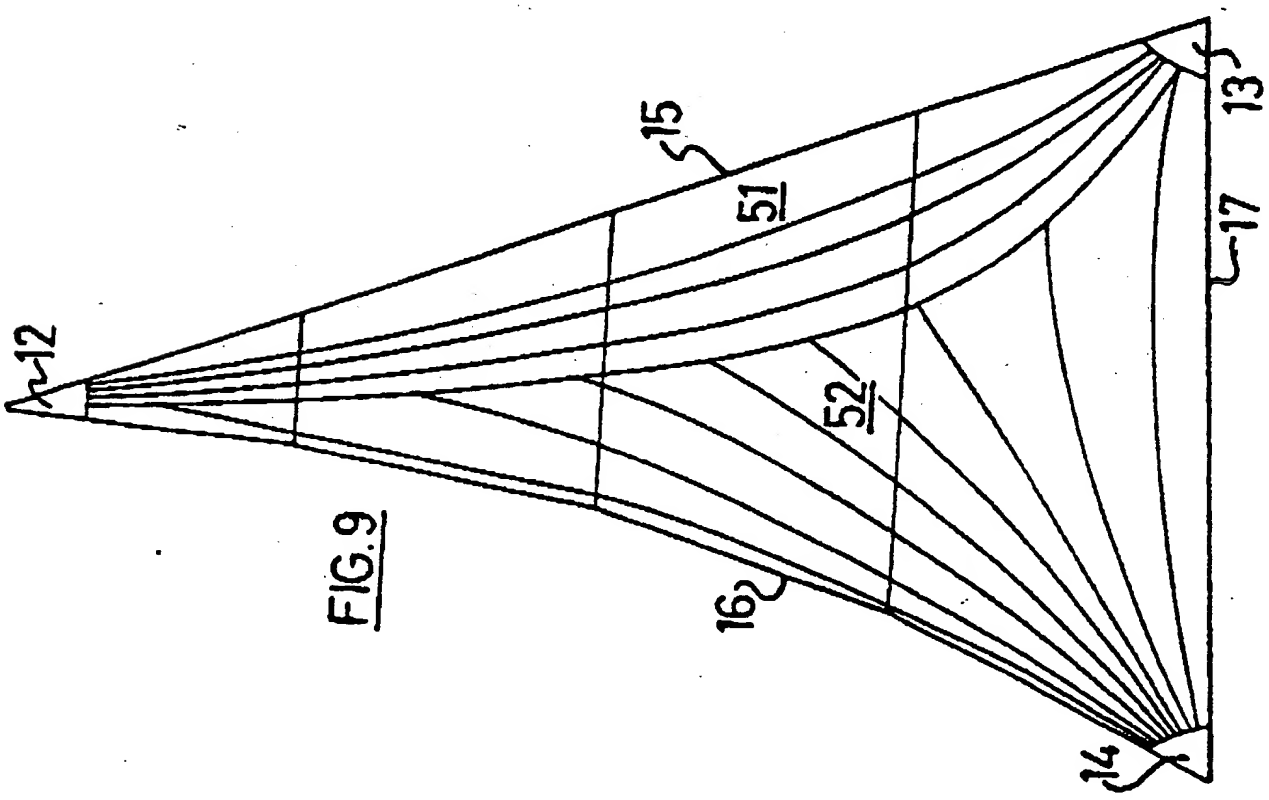


FIG.9

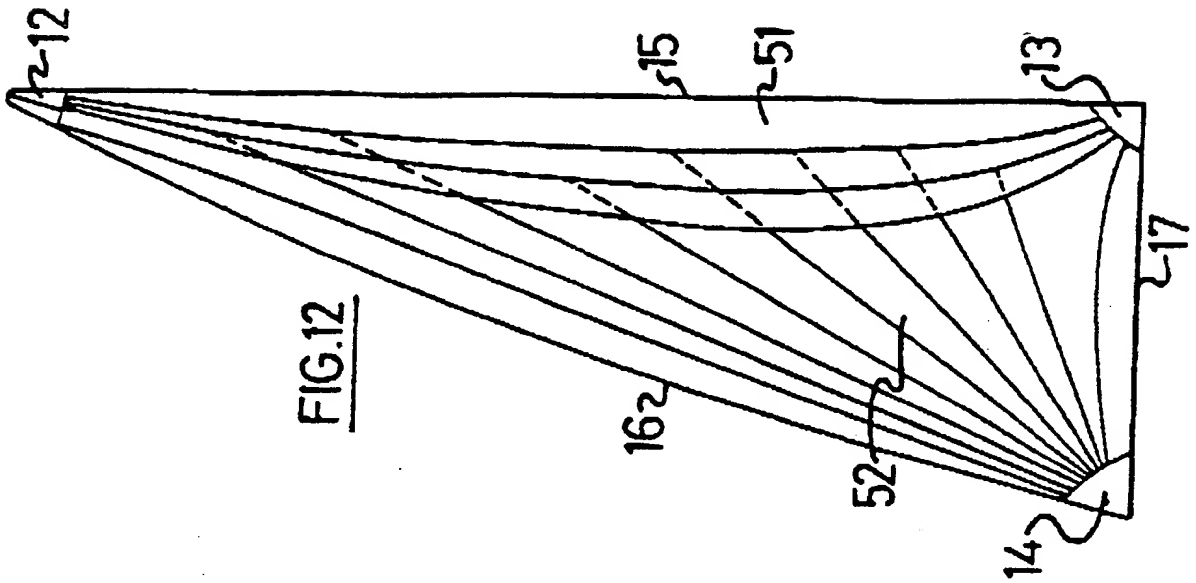
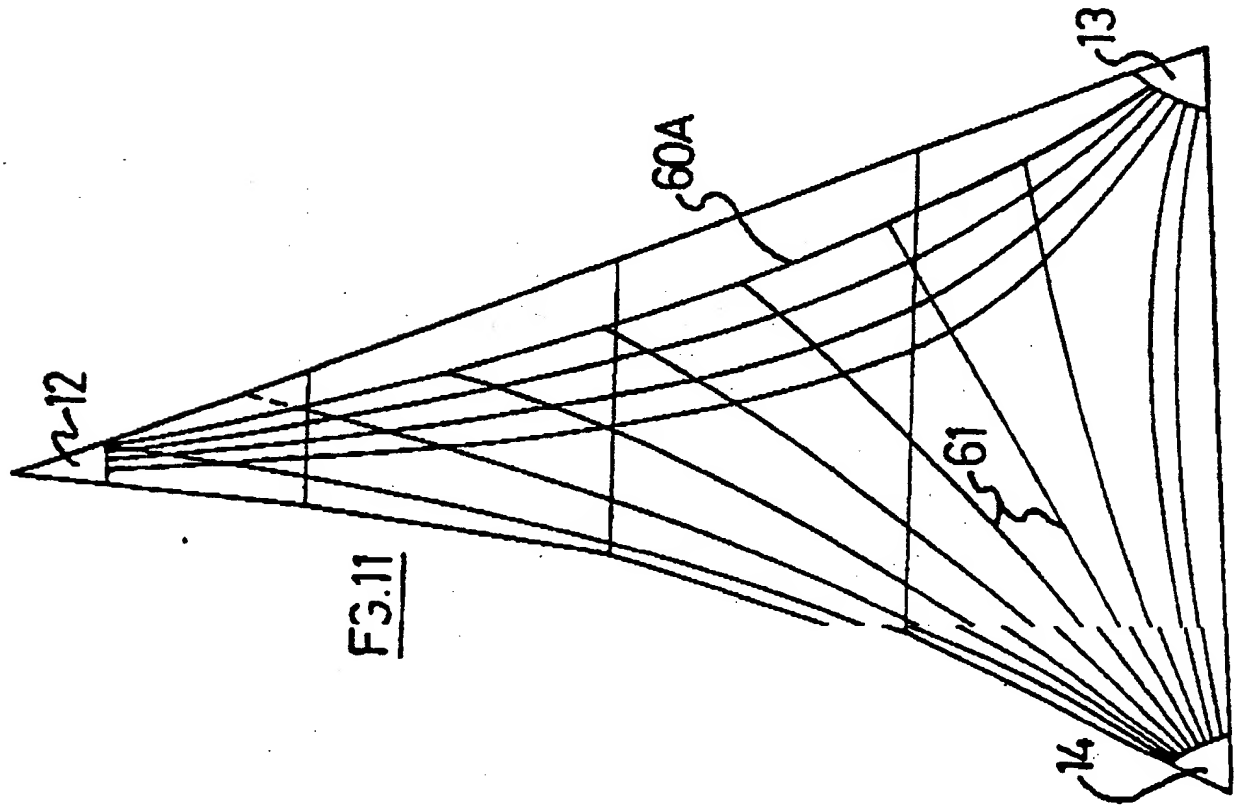


FIG.12



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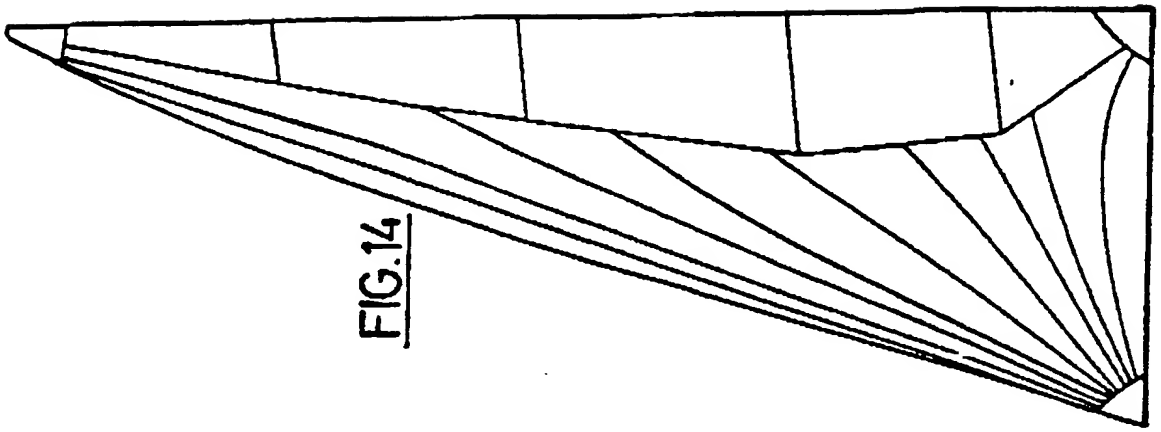

FIG.14

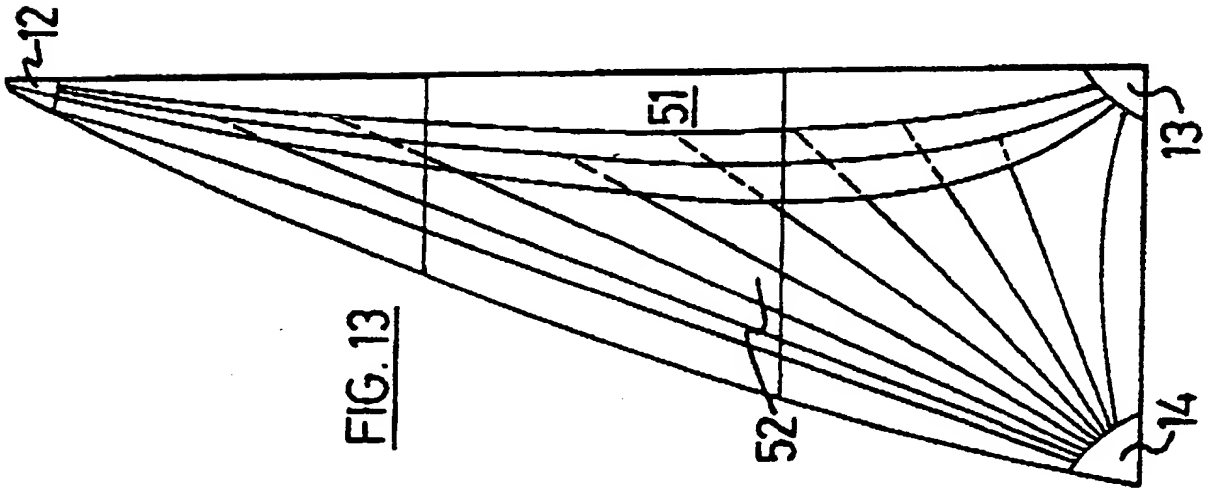

FIG. 13

Eur pean Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 30 9915

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
P,X	EP-A-0 244 729 (BAINBRIDGE AQUABATTEN INC.) * Whole document *	1,2,3,4,5,8	B 63 H 9/06
X	US-A-4 593 639 (SOBSTAD) * Column 7, line 3 - column 9, line 50 *	1,2,3,4,5,6,7,8	
D,Y	EP-A-0 126 614 (LARNASTON) * Page 5, lines 5-29; page 6, line 18 - page 7, line 27 *	1,3,5,9	
Y	US-A-4 476 799 (BANDY) * Column 2, lines 11-59 *	1,2,3,8,9	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 63 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22-02-1988	MARECHAL S.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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